CYCLIC ENDURANCE TEST OF AN AMMONIA ARCJET FOR ELITE/STAR

K.D. Goodfellow and J.E. Polk
Electric Propulsion and Plasma Technology Group
California Institute of Technology
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA, USA

Air Force recognition of the potential for an electric orbit transfer vehicle (EOTV) to provide greater launch vehicle flexibility, increased payload capability, and prolonged on-orbit time has led to formulation of the Electric Insertion Transfer Experiment / Space Track and Autonomous Reposition (ELITE/STAR) flight test. The ELITE/STAR test will demonstrate key power supply and thruster technologies. In one scenario of present interest, unhardened solar arrays initially providing 10 kW of electric power are used to power the spacecraft. Solar array degradation in the Van Allen belts would result in an end-of-life power of 3-4 kw. A series of throttling and endurance tests has recently been conducted at JPL to demonstrate the suitability of the 30 kw class ammonia arcjet for this lower power application. A continuing program is focused on improving the performance of the engine at power levels below 10 kw and demonstrating sufficient lifetime for an EOTV.

Arcjet lifetime appears to be limited primarily by cathode and constrictor erosion. An endurance test of a 30 kW class ammonia arcjet has been recently performed at 10 kW for 1462 hours at JPL. No significant electrode degradation was observed. A subsequent cyclic endurance test revealed an average cathode erosion rate that was 2.7 times that of the continuous operation test. This test, however, was performed using laboratory power supplies.

To confirm reliable operation with realistic on/off cycles, a second cyclic endurance test has been conducted under Air Force Phillips Laboratory sponsorship that includes the TRW Solar Array Simulator and the NASA Lewis Research Center Power Conditioning Unit. The 30 kW class ammonia arcjet was operated at a power of 8 kW with a mass flow rate of 0.18 g/s. The paper will discuss engine behavior during the test, the results of a post-run examination of the electrodes, and the suitability of this design for the ELITE/STAR mission.